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Doped bismuth oxide materials for low-temperature solid oxide fuel cell electrolyte

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Bismuth-oxide based electrolytes are well known for their high oxide ion conductivity at intermediate temperatures (300-700℃). Indeed, the defect fluorite structured δ-phase of Bi2O3 shows the highest known oxide ion conductivity of any material. Unfortunately, this phase is only stable above 730℃ and much research has been carried out on stabilizing this phase to lower temperatures through solid solution formation with other oxides. The aim is to work towards a better understanding of these materials in terms of structure and ion conductivity so that better SOFC electrolytes can be designed to run at lower temperatures (between 300 – 600℃). These materials will thus be studied at elevated temperature ranges. The longer-term stability of promising materials will also be investigated to determine how thermal cycling degrades the material and affects the conductivity.
The effects of Y3+ and Pb2+ double substitutions in Bi2O3 has been examined in the Bi2O3-PbO-Y2O3 system using X-ray powder diffraction (XRD), differential thermal analysis/thermal gravimetry (DTA/TG), and VT-Raman spectroscopy. All these characterization techniques show that samples having Y3+ as a major substituent have a single (δ-phase) phase structure. Pb2+ is isoelectronic with Bi3+, thus the aim of including Pb2+ is to eventually try and gain insight into the effects of the lone pair of electrons in the mobility of the oxide ions through the lattice.

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